

PAPERS.

50. A remarkable new Cirripede from the Chalk of Surrey and Hertfordshire. By THOMAS H. WITHERS, F.G.S.*

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(Plate I.† and Text-figure 1.)

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Among some Cirripede remains recently collected from the Chalk of Surrey are a number of isolated valves, which, together with a remarkably complete specimen of the same species from the Chalk of Watford, Hertfordshire, throw much light on the evolution of the sessile Cirripedes of the family Verrucidæ. They constitute, in fact, the "missing link" between the pedunculate Cirripedes of the family Pollicipedidæ and the sessile asymmetrical Cirripedes of the family Verrucidæ.

The valves from Surrey were obtained by me from a mass of unusually soft Chalk found by Mr. C. P. Chatwin in the Slines Oak Pit, Worms Heath, near Woldingham, and to judge from the single example of *Micraster præcursor* collected from the same horizon, the chalk appears to be in the upper part of the zone of *Micraster cor-testudinarium*. This is the zone to which it has been assigned by Mr. G. W. Young‡.

Much difficulty was experienced in studying these valves, for although they were all somewhat similar in external ornament, the scuta and terga differed so much in structure that it was apparent that more than one species was represented. What was evident, however, was that certain of the scuta and terga, apparently of the same species, were extremely convex transversely and formed a semicircle when placed in position. This fact suggested to me the possibility of their belonging to a new form of sessile Cirripede, since if the capitulum were completed it would approach more closely to radial symmetry than is the case in an ordinary

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† For explanation of the Plate see p. 953.

‡ 1905. "The Chalk Area of North-east Surrey," Proc. Geol. Assoc. London, vol. xix. p. 208 (pit 127a).

pedunculate Cirripede. It was at this stage of my observations that I went to examine some Cirripedes at the Museum of Practical Geology, and among them noticed a beautifully complete example of the species to which most of the isolated valves belong. This fine specimen was collected by Mr. J. Rhodes from the "Upper Chalk of Watford Tunnel,"* and was apparently obtained from a hollow flint at about the same horizon as the isolated valves from Surrey.

Through the kindness of the Director of the Geological Survey and Dr. F. L. Kitchin, I was enabled to borrow this specimen for description.

Although this new Cirripede occupies a position intermediate between the Pollicipedidæ and the Verrucidæ, I do not think it advisable to found a new family for its reception. It will, I think, be sufficiently distinguished if it is placed in a new genus, and the diagnosis of the family Verrucidæ extended to include it, since it is undoubtedly a primitive Verrucid.

The remaining valves, which obviously do not belong to this Verrucid, are described as a new species of *Scalpellum* (*sensu lato*).

Family VERRUCIDÆ emend.

Sessile, asymmetrical, box-like* barnacles, in which a scutum, tergum, rostrum, and carina, with or without a rostral- and a carinal-latus in addition, are immovably united to form the "wall"; the remaining scutum and tergum are movable, and form the lid-like top.

PROVERRUCA, gen. nov.

Verrucids in which a rostral- and a carinal-latus are present on the rostro-carinal side, and in which none of the valves has developed interlocking ribs.

PROVERRUCA VINCLUM †, sp. n. (Pl. I. figs. 1-9; Text-fig. 1, C-F.)

Material.—(1) A single complete individual in which the movable scutum is somewhat displaced, and the upper portion of the rostral-latus broken away. (2) A number of isolated valves comprising:—1 fixed scutum (left), 6 fixed terga (5 right and 1 left), 4 movable scuta (1 right and 3 left), 2 movable terga (left), 1 carinal-latus (right), and 2 rostral lateral valves (left). There are no isolated examples of the rostrum and carina. Seven individuals are represented by these remains.

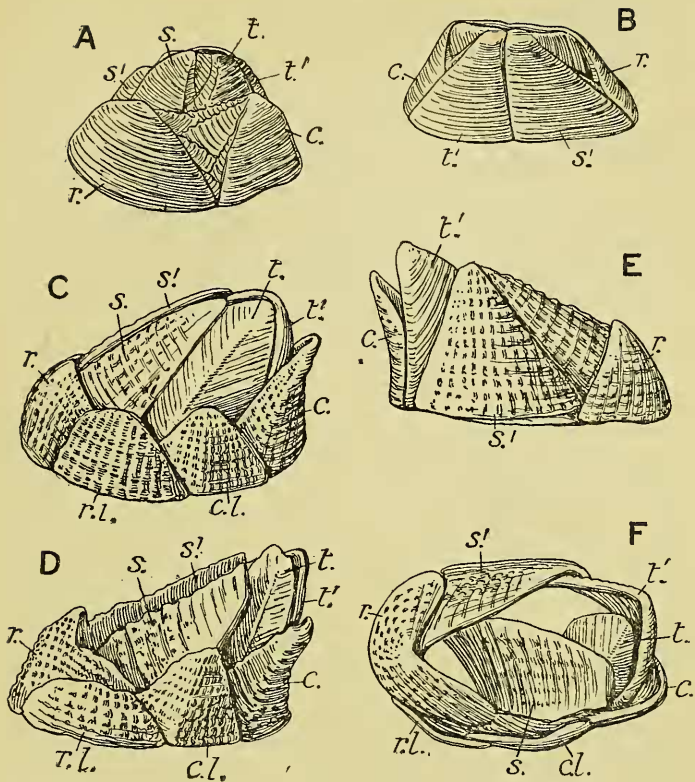
Holotype.—The complete specimen (text-fig. 1, C-F), Museum of Practical Geology, register number 3204.

Horizon and locality.—Lower Senonian, Upper part of *M. costudinarium*-zone: Slines Oak Pit, Worms Heath, Woldingham, Surrey. ? Same horizon: Watford Tunnel, Hertfordshire.

* 1889. Mem. Geol. Surv., Geology of London, vol. i. p. 77; 1904. Mem. Geol. Surv., Cretaceous Rocks, vol. iii. p. 232.

† *vinculum*, a bond.

Text-figure 1.



A. *Verruca prisca* J. Bosquet. Upper Senonian to Danian: Europe. Rostrocarinal view showing the movable opercular valves, which are on the right side.

B. Opposite view of same showing the fixed scutum and tergum.

C. *Proverruca vinculum*, gen. et sp. n. Lower Senonian: England. Restoration of specimen below (fig. D), and from almost the same position.

D. *Proverruca vinculum*, gen. et sp. n. Lower Senonian, ? zone of *Micraster costudinarium*: Watford Tunnel, Hertfordshire. Coll. Mus. Pract. Geol., No. 3204. A complete shell in which the movable scutum and tergum are on the right side and slightly displaced. The rostral- and the carinal-latus are seen, but the rostral-latus has its upper part broken away showing the lateral portion of the rostrum below.

E. Opposite view of same showing the fixed scutum and tergum.

F. Same specimen viewed from above to show the broadly oval outline of the shell, and the semicircular outline formed by the fixed scutum and tergum.

c., carina; c.l., carinal-latus; r., rostrum; r.l., rostral-latus; s., movable scutum; s', fixed scutum; t., movable tergum; t', fixed tergum.

All figures $\times 15$ diam.

Measurements.—The complete shell is very minute, its dimensions being:—

Length (from base of rostrum to apex of carina)	2·7 mm.
" (from apex " " ")	2·1 mm.
Greatest breadth	1·7 mm.
" height (from apex of tergum to base)...	1·6 mm.

The isolated valves are somewhat larger, and indicate that the complete specimen is a young individual. Their dimensions are:—

Movable scutum: length (from apex to middle of basal margin) 2·8 mm.; breadth (greatest) 1·2 mm.

Fixed scutum: length (from apex to middle of basal margin) 2·7 mm., when complete, ca. 2·9 mm.; length (from apex to rostral angle) 3·1 mm.; breadth (greatest) 2·7 mm.

Fixed tergum: length 2·4 mm.; breadth 1·7 mm.

Description of Specimens.

Although the complete specimen is of great importance as showing the relative position of the valves, little can be seen of their inner structure. Moreover, the valves are covered exteriorly by a film of chalk, or may be a secondary deposit of silica, which serves both to obscure and unduly to emphasize the bead-like ornament. This is no doubt due to the shell having been preserved in a hollow flint, for preservation in flints is apt, especially in highly ornamented forms, to make the ornament more pronounced. Owing to its importance it is too dangerous to attempt to clean this minute and delicate fossil, and it will have to be studied in its present condition.

The isolated valves vary considerably both in ornament and structure, but while there is no doubt as to the identity of the fixed and movable scuta and terga, it is not at all certain that the rostral- and the carinal-latus belong to this species. In the complete specimen the rostral-latus is much broken, and the outer structure of this and the carinal-latus somewhat obscured. Without being able to disarticulate these valves it is impossible to compare them with the supposed isolated examples, of which even the two rostral latera differ from each other. It is probable that the variation in ornament is due to varying states of preservation.

The shell is broadly oval in outline, much elevated, the walls perpendicular on each side, and the movable scutum and tergum, when in position, would be inclined at an angle of about 30° with the base; rostrum and carina at either end, the rostrum wider than the carina and slightly more developed on the right side, the space between the rostrum and carina occupied on one side by the fixed scutum and tergum, and on the other by the carinal-latus, the rostral-latus for its whole length overlapping the lateral portion of the rostrum.

Valves highly ornamented, the ornament consisting of strong

transverse ridges, which, where crossed by the longitudinal ridges, are broken up into bead-like prominences. The fixed and the movable tergum have this bead-like ornament only on the apico-basal ridge, the longitudinal ridges being absent on the remainder of the valve. On the movable scutum the longitudinal ridges are prominent only near the occludent margin.

Rostrum widely semiconical, wider than the carina, bowed inwards, its apex not freely projecting, and the lateral portion slightly more produced on the rostro-lateral side, on which the transverse arrangement of the ornament is pronounced.

Carina subtriangular, bowed outwards, moderately convex transversely, the apex freely projecting; a short distance from the carino-lateral margin and extending from the apex, is a prominent longitudinal ridge formed by the valve being folded along this line.

Fixed scutum (Pl. I. figs. 1 *a*, *b*) subtriangular, apex acuminate, considerably convex transversely, with a wide submedian fold or ridge extending from the apex; on the occludent side of the ridge the growth-lines are upturned, and on the tergal side almost straight; occludent and basal margins convex; tergal margin concave. On the inner surface a comparatively wide portion of the valve near the occludent and tergal margins is marked with growth-lines which meet on a raised ridge below the apex; this ridge serves for the reception of the scutal angle of the tergum. The pit for the adductor muscle takes up a considerable portion of the lower half of the valve.

Fixed tergum (Pl. I. figs. 4 *a*, *b*) subrhomboidal, considerably convex transversely, with a flat-topped apico-basal ridge which widens gradually downwards, and on this ridge the transverse ridges are broken up into small bead-like prominences owing to the crossing by the longitudinal ridges; basal margin acutely to broadly rounded. On the inner surface the apical portion is marked with growth-lines for about one-fourth the extent of the valve.

Lateral valves.—The two lateral valves seen in the complete specimen from Watford are somewhat broken, and as already stated, I am uncertain whether the three isolated valves are identical with them, or whether they belong to the species described (p. 952) as *Scalpellum vimineum*, sp. n. The two right valves, considered to be rostral-latera, are obliquely triangular in shape and considerably convex transversely. One (Pl. I. figs. 9 *a*, *b*) has the inner surface near the rostral margin marked with growth-lines to a greater extent than in the other valve (Pl. I. figs. 8 *a*, *b*). The latter differs also in the direction of the transverse ridges on the outer surface, for along a line extending from the apex near to the rostral margin, the transverse ridges are not continuous but bend abruptly but slightly upwards and then downwards to the margin. The right valve, regarded as a carinal-latus (Pl. I. figs. 7 *a*, *b*), is subtriangular in shape and very gently convex transversely. On the inner surface the basal

fourth of the valve only was covered by the corium, the upper three-fourths being marked with growth-lines, which indicate that the valve freely projected to that extent.

Movable scutum (Pl. I. figs. 2, 3 *a*, *b*) an acute-angled isosceles triangle, slightly bowed towards the tergum, but more so away from the opposing scutum; basal and tergal margins almost straight; occludent margin convex. On the inner surface a narrow portion of the valve along the occludent edge is thickened, and a shallow pit for the adductor muscle is situated about the middle of the valve. On the tergal side the inner edge is raised, and between it and the outer edge is formed a narrow groove for the reception of the tergum.

Movable tergum (Pl. I. figs. 5 *a*, *b*, 6) of an elongate diamond shape, almost flat transversely, with a sharp-edged apico-basal ridge; carinal margin formed of two lines making an obtuse angle; scutal angle slightly protuberant.

Affinities of the Genus.—From a phylogenetic standpoint *Proverruca* is by far the most important fossil Cirripede that has yet been discovered, for it serves in a most remarkable manner to link up the hitherto distinct families Pollicipedidæ and Verrucidæ.

The family Verrucidæ consists of only the single genus *Verruca*, but the genus includes some 48 species. Of these, two occur in the Upper Cretaceous (Upper Senonian and Danian), five are confined to Tertiary rocks (Miocene and Pliocene), and there are 41 recent species, of which one occurs also in the Pliocene. The shell of *Verruca* is very peculiar, since it is quite asymmetrical owing to the unequal development of the valves. There are six valves, and Darwin* has shown by tracing the development of the young shell that they consist on one side of the carina and rostrum unequally developed on their two sides, on the other of a tergum and scutum most peculiarly modified and immovably interlocked to form the "wall" with the rostrum and carina, and a scutum and tergum in their normal and movable condition forming the top of the shell. Both Darwin† and Gruvel‡ have shown that at the first period of calcification the valves are almost symmetrical, but during the subsequent growth of the shell become more and more unequally developed to form the asymmetrical shell typical of the Verrucidæ. It is interesting also that it appears to be a matter of chance whether it is the right- or left-hand scutum and tergum that are modified to form the wall with the rostrum and carina.

Proverruca is of a much more primitive structure than *Verruca*, and although the valves are disposed to form an asymmetrical shell as in *Verruca*, with the exception of the inequality in size of the fixed and movable scuta and terga, the valves have

* 1854. Ray Soc. Monogr. Sub-class Cirripedia, Balanidæ and Verrucidæ, p. 498.

† 1855. Palæont. Soc. Monogr. Foss. Balanidæ and Verrucidæ, p. 41.

‡ 1854. Ray Soc. Monogr. Sub-class Cirripedia, Balanidæ and Verrucidæ, p. 497.

§ 1905. 'Monographie des Cirrhipèdes ou Théostracés,' p. 170.

undergone very little modification in structure from an ordinary pedunculate Cirripede. The fixed scutum and tergum have a greater transverse convexity than in an ordinary pedunculate Cirripede, but, unlike those of *Verruca*, they can be readily identified. In fact, they prove the correctness of Darwin's interpretation of the valves in *Verruca* as deduced from a study of the valves of the young shell. As is shown by the right and left movable scuta and terga, it is a feature of both genera that either the right or left valves may be developed to form the "wall."

If we take such a pedunculate Cirripede as is included in the sub-genus *Scillalepas* of the genus *Calantica*, we see that the capitulum is composed of two whorls of valves, the upper comprising paired scuta and terga, and a carina, the lower whorl consisting of three pairs of latera, a rostrum, and a sub-carina. There is no upper lateral valve between the scutum and tergum, although the median lateral valve may be homologous with the valve that becomes an upper lateral valve in the more specialized forms of *Scalpellum*. Now if we imagine the almost equal development of the rostrum and carina, and the suppression on one side of the lateral valves, the scutum and tergum would be allowed to form that side of the wall, and the opposing scutum and tergum would have to lean over at a greater angle to meet them. We should then have only to suppress the sub-carina, the median latus, and the peduncle, to get a form such as *Proverruca*. This was evidently the history of the form, and although *Scillalepas* may not have been the actual ancestor, it must have been a form somewhat similar. *Proverruca* still retains the primitive structure of the valves, as is shown by the isolated examples, and the two lateral valves, regarded as homologous with the rostral- and the carinal-latus in the Pollicipedidæ, are two that remain of the three lateral valves. It is of much significance that of these two valves only the carinal-latus really forms that part of the wall between the rostrum and carina. The rostral-latus overlaps for its whole length the lateral portion of the rostrum, and it certainly seems as though with the approaching attachment of the lateral portions of the rostrum and carina, the two lateral valves were on their way to suppression. We have only to imagine their absence, the meeting of the rostrum and carina, and the development of interlocking ribs to strengthen the attachment of the valves, to turn *Proverruca* into a typical *Verruca* (text-fig. 1, A, B.)

We see that in the non-attachment of the rostrum and carina, the presence of two lateral valves, and in the structure of the fixed scutum and tergum, *Proverruca* is related to the Pollicipedidæ, but more particularly to the genus *Calantica* Gray. In the asymmetry of the shell owing to the unequal development of the valves on both sides, and in one of the scuta and terga forming the operculum, it is related to *Verruca*, and it is especially near to the recent deep-sea species with elevated shells. *Proverruca* undoubtedly represents the ancestral type from which has arisen the

recent group of asymmetrical sessile Cirripedes forming the family Verrucidæ, and in its structure clearly shows its origin from the symmetrical pedunculate forms of the family Pollicipedidæ. It presents further evidence that the sessile condition has been arrived at independently on several different lines of descent during the evolution of the Cirripedia. The Verrucidæ have a phylogenetic history widely different from that of the Balanidæ (*sensu lato*), and evidence is not wanting to show that the Balanidæ also are at least diphyletic. The Chthamalinæ have almost certainly arisen from some such form as *Brachylepas*, while it is extremely difficult, if not impossible, to derive the Balaninæ from that source, or indeed from any form as yet known.

Family POLLICIPEDIDÆ.

SCALPELLUM VIMINEUM *, sp. n. (Pl. I. figs. 10-12.)

Diagnosis.—Scutum subtrapezoidal, with no apico-basal ridge, the apex rounded, the growth-ridges arranged in concentric lines from the apex; ocludent margin forming a right angle with the basal margin.

Material.—Portions of a right and a left scutum, and a complete right tergum which might or might not belong to the same species.

Holotype.—The left scutum (figs. 10 *a*, *b*).

Horizon and locality.—Lower Senonian, upper part of *M. cor-testudinarium*-zone: Slines Oak Pit, Worms Heath, Woldingham, Surrey.

Measurements.—Length of left scutum, 2.9 mm.; length of left tergum 1.9 mm., breadth, 1.2 mm.

Scutum.—The left valve (Pl. I. figs. 10 *a*, *b*), which is more nearly complete, has the tergo-lateral portion almost entirely broken away, and is gently convex transversely. When complete the valve was subtrapezoidal in outline, and there is no apico-basal ridge. Apex rounded; basal margin convex, and forming a right angle with the lower part of the convex ocludent margin. Outer surface ornamented with a number of concentric ridges terminating each zone of growth, and these ridges are broken up into bead-like prominences where crossed by the longitudinal ridges. The middle portion of the valve has the bead-like prominences much more numerous and crowded. A wide portion of the inner surface on the ocludent side, and so far as preserved on the tergal side, is marked with growth-lines which meet on a raised ridge below the apex. A deep pit for the adductor muscle is situated in the middle of the basal portion of the valve.

Tergum (Pl. I. figs. 12 *a*, *b*) subrhomboidal, with a delicate apico-basal furrow; apex slightly curled towards the scutum, basal portion narrow and pointed. Upper carinal margin slightly

* *vimineus*, made of wicker-work.

convex, a little shorter than the lower margin, which is straight; occludent margin extremely short, and the scutal angle much rounded and protuberant; the valve is depressed near the scutal angle, and forms a ridge parallel to the margin. Outer surface ornamented with delicate transverse ridges.

Remarks and Comparison with other Species.—These three valves were found with those of *Proverruca vinculum*, already described (p. 946), but there is no evidence to show that they belong to one individual. The scutum is ornamented like the valves of *P. vinculum*, but it differs so much from the homologous valve of that species that I refer it to a new species, and to the genus *Scalpellum* (*sensu lato*). The small transverse convexity of the valve seems to preclude the possibility of its having formed part of a shell as is the case in *Proverruca*, and therefore representing a second species of the genus. Its structure renders it more probable that it formed part of a capitulum of a pedunculate Cirripede of the genus *Scalpellum*, but further information is needed as to the remaining valves before anything more definite can be said regarding the relationship of the species.

The scutum differs from that of *Proverruca vinculum*, mainly in its much less triangular shape, in the occludent and basal margins forming an angle of 90° instead of about 45° , and in the absence of an apico-basal ridge. The tergum differs chiefly in the presence of a delicate apico-basal furrow, instead of a prominent ridge.

My thanks are due to Dr. F. A. Bather, Dr. W. T. Calman, and Mr. C. P. Chatwin for help in connexion with this paper.

EXPLANATION OF THE PLATE.

Proverruca vinculum, gen. et sp. n.

Lower Senonian, Upper part of *M. cor-testudinarium*-zone: Slines Oak Pit, Worms Heath, Woldingham, Surrey.

- Fig. 1. Fixed scutum. *a*, outer view of left valve; *b*, inner view.
 2. Movable scutum. Outer view of a comparatively wide left valve.
 3. Movable scutum. *a*, outer view of left valve; *b*, inner view.
 4. Fixed tergum. *a*, outer view of left valve; *b*, inner view.
 5. Movable tergum. *a*, outer view of left valve with basal portion broken away; *b*, inner view.
 6. Movable tergum. Outer view of smaller but more complete left valve.
 7. Carinal-latus. *a*, outer view of right valve; *b*, inner view.
 8. Rostral-latus. *a*, outer view of incomplete left valve; *b*, inner view.
 9. Rostral-latus. *a*, outer view of nearly complete left valve; *b*, inner view.

Scalpellum vimineum, sp. n.

10. Scutum. *a*, outer view of left valve of which the tergal portion is broken away; *b*, inner view.
 11. Scutum. *a*, outer view of fragment of a right valve (portion near rostral angle) with very pronounced ornament; *b*, inner view.
 12. Tergum. *a*, outer view of complete right valve; *b*, inner view.

All figures \times circa 8 diameters.